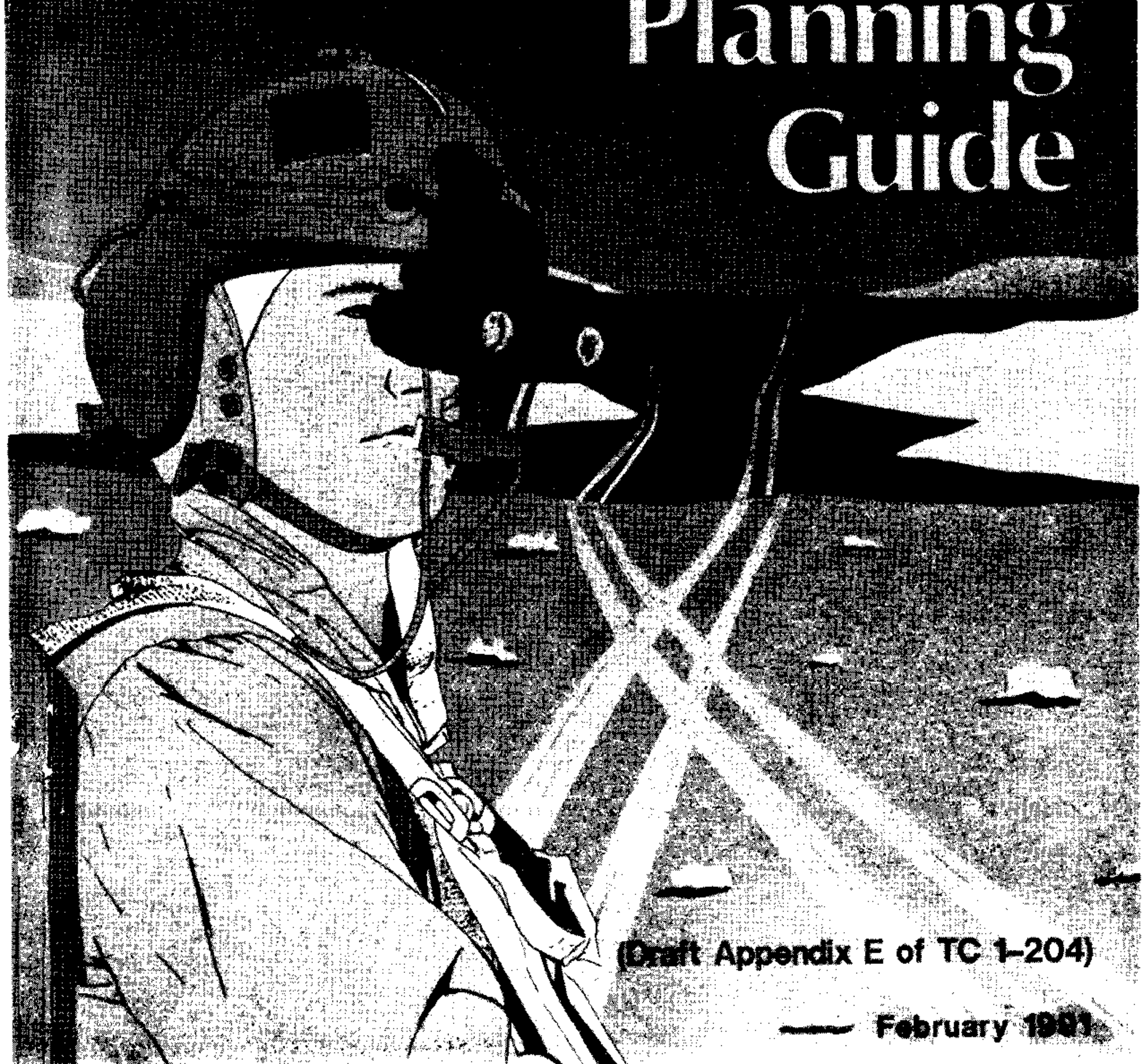
Aviation NVG Desert Training and Operations Planning Guide



(Draft Appendix E of TC 1-204)

February 1991

FOREWORD

Operations Desert Shield and Desert Storm have presented Army aviation with some challenges to the safe operation of our aircraft under night vision goggle conditions. The combination of visual illusions, featureless terrain, and extreme temperatures creates unforgiving situations for *untrained* night vision goggle crews. Experience has proven that commanders who focus on desert-specific night vision goggle training, battle rostering crews, and crew coordination will be able to reduce the risks associated with desert flying. Operations Desert Shield and Desert Storm have required that certain long-standing night flight procedures and techniques be re-examined, the most significant of these being Aircrew Training Manual airspeed limitations. This draft appendix E to TC 1-204 includes new planning guidance appropriate for the environment in Southwest Asia.

Suggest you use this guidance for operational planning and the crawl-walk-run progression of unit night vision goggle training programs in Southwest Asia. This guide is intended to improve your combat effectiveness through smarter, safer flight training and operations.

RUDOLPH OSTOVICH III
Major General, Commander
U.S. Army Aviation Center and Fort Rucker

Aviation NVG Desert Training and Operations Planning Guide

(Draft Appendix E of TC 1-204)

TABLE OF CONTENTS

SECTION I

INTRODUCTION

The airborne sand, featureless terrain, and sand dunes prevalent in Southwest Asia present aviators with a hazardous environment for night vision goggle operations. To provide planning guidance specifically oriented toward this environment, a research project sponsored by the Director of Army Safety and directed by the U.S. Army Safety Center was conducted in Southwest Asia during the period 1-30 December 1990. The primary purpose of the project was to determine maximum airspeeds, optimum altitudes, and auxiliary aircraft lighting for safer NVG operations under the full spectrum of illumination levels for terrains characteristically encountered.

Evaluation flights were conducted by two highly experienced instructor pilots from Fort Rucker along with two such pilots assigned to Operation Desert Shield aviation units. Two UH-1H aircraft with radar altimeters were used and pilots were equipped with AN/AVS-6 goggles. A series of flights were conducted over three different types of terrain prevalent in Southwest Asia (scrub, dry lake bed, and sand dunes) with various altitude, airspeed, and lighting configurations. Video and audio tapes, interviews of in-theater pilots, and quantitative data were used to develop the information contained in this planning guide.

SECTION II

ILLUMINATION

Illumination level is one of the most important factors in NVG mission planning. Section II-A below contains illumination considerations for desert regions that, while applicable in all areas of the world, may be more important to planners of NVG missions in Southwest Asia. Section II-B provides sources of illumination data for use in NVG mission planning.

A. ILLUMINATION CONSIDERATIONS

MOON POSITION

■ Use forecast moon position in NVG planning process to ensure crews do not fly directly into a rising or setting moon.

■ Moon angle:

• Moon at low angles (less than 30 degrees) may distort the shape of terrain features, making them hard to correlate with a map.

• Moon at high angles (70 to 90 degrees) and high illumination levels (above 80%) can cause washout of terrain detail with a corresponding decrease of visual cues.

■ Optimum moon conditions for NVG operations in the desert may be 40- to 80-percent illumination and a 40- to 80-degree angle above the horizon.

■ Obstacle detection is best when moon is behind the aircraft.

■ Shadows.

• If necessary, shadows provided by terrain features can be used to hide the aircraft.

• Shadows can be used as visual cues for spatial orientation.

• In terrain with high vertical relief, when the moon is located behind the aircraft, terrain features stand out more and shadows extend away from the aircraft.

• When moon is located to either side of aircraft, obstacle detection can become difficult because lateral shadows can obscure obstacles.

SUNRISE AND SUNSET

■ Position of the sun should be considered when operations are planned near sunset and sunrise because over-the-horizon sunlight can degrade NVG effectiveness.

■ *Avoid* flying due west immediately after sunset or due east just before sunrise to avoid bright over-the-horizon sunlight.

■ Over-the-horizon sunlight may be too bright at—

• Sunset until the sun drops beyond 12 degrees below the horizon (end of evening nautical twilight).

• Sunrise as the sun rises from 12 degrees below the horizon.

CULTURAL LIGHT CONTAMINATION

■ Cultural light contamination (effect of lighting from cities, fires, flares, etc.) is difficult to predict.

■ Cultural light increases total ambient illumination level.

■ Point light sources may reduce ability to detect/identify terrain features lying between them and the NVG user.

OTHER CONSIDERATIONS

■ When forecast ambient light level is very low or very high, assign a *higher risk* factor for the mission during planning.

■ When light level is very high, the reflectance of sand can reduce detectability of obstacles in the foreground.

■ Fog, smoke, haze, sand, and dust will diffuse light and reduce the effectiveness of available illumination.

B. ILLUMINATION DATA SOURCES

SOURCES. Illumination data can be obtained from—

- U.S. Air Force Weather Service
- Computer programs such as Tactical Decision Aid (TDA) and Light Level Planning Calendar (LUNACAL)

DESCRIPTION OF TDA AND LUNACAL

- **TDA**
  - Used by some U.S. Air Force weather forecasters.
  - Primarily an electro-optical forecasting tool used to determine infrared target detection and identification ranges based on local weather, terrain, and target activity.
  - Can provide NVG mission planners with moon zenith, set times, percent illumination, angle, and position in the sky relative to True North.
  - May be obtained from local U.S. Air Force weather forecaster.
- **LUNACAL**
  - Provides predictions of sun and moon positions for any point on the earth designated by latitude and longitude.
  - May be obtained from local U.S. Air Force weather forecaster.
  - Examples of LUNACAL output for the months of February through June 1991 are included in Charts 1 through 5 for Kuwait City (latitude 29 degrees 22 minutes North, longitude 48 degrees 00 minutes East, GMT +3).

** Light level planning calender , Clear sky condition **

Latitude N 29 degrees 22 minutes   Longitude E 48 degrees 0 minutes

1 February 1991 to 28 February 1991

```
 For   Moon  Sun  %Mn@ 1700    1800    1900    2000    2100    2200    2300    2400    0100    0200    0300    0400    0500    0600    0700    0800 For   Moon  Sun
PM on   R/S  set  2400  !       !       !       !       !       !       !       !       !       !       !       !       !       !       !       ! AM on  R/S  rise
 1 Feb R1955 1726  91% ...XXXXXXXXXXXXXXXXXXXXX00                 -----------------------------------------------------------      ............  2 Feb S0822 637
 2 Feb R2056 1726  84% ...XXXXXXXXXXXXXXXXXXXXXXXXXXXXX000                ---------------------------------------------------------  ............  3 Feb S0853 636
 3 Feb R2155 1727  76% ...XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX0000                ------------------------------------------------............  4 Feb S0925 636
 4 Feb R2253 1728  66% ...XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX0000                ----------------------------------------............  5 Feb S0958 635
 5 Feb R2350 1729  57% ...XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX00000                 ------------------------------............  6 Feb S1034 635
 6 Feb none  1730  47% ...XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX00000000               ---------------------............  7 Feb R0047 634
 7 Feb none  1731  38% ....XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX0000000000             ------------............  8 Feb R0142 633
 8 Feb none  1731  29% ....XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX0000000000000000      ----............  9 Feb R0236 632
 9 Feb S1246 1732  21% ....XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX0000000000000000000000............ 10 Feb R0326 632
10 Feb S1338 1733  14% ....XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX000000000000000............ 11 Feb R0412 631
11 Feb S1434 1734   8% ....XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX0000000000............ 12 Feb R0453 630
12 Feb S1531 1735   3% ....XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX00000............. 13 Feb R0531 629
13 Feb S1629 1735   1% ....XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX00............. 14 Feb R0605 628
14 Feb S1727 1736   0% ....XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX............. 15 Feb R0637 628
15 Feb S1825 1737   1% ....00000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX............. 16 Feb R0708 627
16 Feb S1923 1738   5% ....000000000000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX............. 17 Feb R0739 626
17 Feb S2022 1738  11% ....0000000000000000000000000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX............. 18 Feb R0811 625
18 Feb S2123 1739  18% ....0000000000000000000000000000000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX............. 19 Feb R0845 624
19 Feb S2226 1740  27% ....-------------------   0000000000000000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX............. 20 Feb R0925 623
20 Feb S2332 1741  38% .....----------------------------       000000000000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX............. 21 Feb R1010 622
21 Feb none  1741  49% .....------------------------------------           000000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX............. 22 Feb S0038 621
22 Feb none  1742  61% .....--------------------------------------------            0000000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX............. 23 Feb S0144 620
23 Feb R1203 1743  71% .....----------------------------------------------------               0000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX.............. 24 Feb S0244 619
24 Feb R1309 1743  81% .....------------------------------------------------------------               000XXXXXXXXXXXXXXXXXXXXXXX.............. 25 Feb S0338 618
25 Feb R1417 1744  89% .....------------------------------------------------------------------                000XXXXXXXXXXXXXXXX.............. 26 Feb S0426 617
26 Feb R1526 1745  95% ..... -----------------------------------------------------------------------               00XXXXXXXXXXX.............. 27 Feb S0507 616
27 Feb R1632 1746  99% .....          --------------------------------------------------------------------                 0XXX................ 28 Feb S0544 615
 Date   R/S  Sun  %Mn@  !       !       !       !       !       !       !       !       !       !       !       !       !       !       !       ! Date   R/S  Sun
       Moon  set  2400 1700    1800    1900    2000    2100    2200    2300    2400    0100    0200    0300    0400    0500    0600    0700    0800       Moon  rise
```

(....) indicates Sun above horizon
(XXXX) indicates Moon below horizon
(0000) indicates Moonlight Level less than .003 lux and moon not 23% illuminated or not 30 deg above horizon or neither
(   ) indicates Moonlight Level greater than or equal to .003 lux but moon not 23% illuminated or not 30 deg above horizon
(----) indicates the Moon is at least 23 percent illuminated and at least 30 degrees above the horizon

** Data provided by U.S. Army Aeromedical Research Laboratory **

```
**************************************** Light level planning calender , Clear sky condition ******************************************
                                  Latitude N 29 degrees 22 minutes    Longitude E 48 degrees 0 minutes

                                                   1 March 1991  to  31 March 1991

  For   Moon  Sun  %Mn@ 1700  1800  1900  2000  2100  2200  2300  2400  0100  0200  0300  0400  0500  0600  0700  0800 For    Moon  Sun
 PM on   R/S  set  2400  !     !     !     !     !     !     !     !     !     !     !     !     !     !     !     ! AM on  R/S   rise
  1 Mar R1838 1747  98%  .....XXXXX00             --------------------------------------------           ...........  2 Mar S0650 613
  2 Mar R1938 1748  95%  .....XXXXXXXXXXX00              ---------------------------------------         ...........  3 Mar S0722 612
  3 Mar R2038 1748  89%  .....XXXXXXXXXXXXXXXXX000             ------------------------------------      ...........  4 Mar S0755 611
  4 Mar R2136 1749  82%  .....XXXXXXXXXXXXXXXXXXXXXXX000              -------------------------------    ...........  5 Mar S0831 610
  5 Mar R2234 1750  74%  .....XXXXXXXXXXXXXXXXXXXXXXXXXXXXX0000              --------------------------  ...........  6 Mar S0909 609
  6 Mar R2331 1750  65%  .....XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX00000              --------------------............  7 Mar S0952 608
  7 Mar none  1751  55%  ......XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX0000000             --------------............  8 Mar R0026 607
  8 Mar none  1752  46%  ......XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX000000000           ---------............  9 Mar R0118 606
  9 Mar none  1752  37%  ......XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX00000000000        -----............ 10 Mar R0205 604
 10 Mar S1223 1753  28%  ......XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX0000000000000000 -............. 11 Mar R0248 603
 11 Mar S1319 1753  20%  ......XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX0000000000000000............ 12 Mar R0327 602
 12 Mar S1417 1754  12%  ......XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX0000000000000............ 13 Mar R0403 601
 13 Mar S1514 1755   7%  ......XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX00000000............. 14 Mar R0436 560
 14 Mar S1613 1755   2%  ......XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX00000............. 15 Mar R0508 559
 15 Mar S1711 1756   0%  ......XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX00............. 16 Mar R0539 557
 16 Mar S1811 1756   1%  ......00XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX............. 17 Mar R0611 556
 17 Mar S1913 1757   3%  ......00000000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX............. 18 Mar R0646 555
 18 Mar S2017 1758   8%  ......00000000000000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX............. 19 Mar R0724 554
 19 Mar S2123 1758  15%  ......00000000000000000000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX............. 20 Mar R0808 553
 20 Mar S2230 1759  24%  ......         000000000000000000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX............. 21 Mar R0859 552
 21 Mar S2336 1759  34%  ......------------------     00000000000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX............. 22 Mar R0956 550
 22 Mar none  1800  46%  ......------------------------        0000000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX.............. 23 Mar S0038 549
 23 Mar none  1801  57%  .......-----------------------------         000000XXXXXXXXXXXXXXXXXXXXXXXXXX.............. 24 Mar S0134 548
 24 Mar R1207 1801  68%  .......----------------------------------         00000XXXXXXXXXXXXXXXXXXXXXX.............. 25 Mar S0222 547
 25 Mar R1314 1802  78%  .......--------------------------------------          0000XXXXXXXXXXXXXXXXXX.............. 26 Mar S0304 546
 26 Mar R1419 1802  87%  .......------------------------------------------           000XXXXXXXXXXXXXX.............. 27 Mar S0341 545
 27 Mar R1523 1803  93%  .......----------------------------------------------           00XXXXXXXXXXX.............. 28 Mar S0415 543
 28 Mar R1624 1804  98%  .......   ----------------------------------------------            0XXXXXXXX.............. 29 Mar S0448 542
 29 Mar R1724 1804 100%  .......          ------------------------------------------               XXX.............. 30 Mar S0520 541
 30 Mar R1823 1805  99%  .......XX0            ---------------------------------------               0.............. 31 Mar S0552 540
  Date  R/S   Sun  %Mn@  !     !     !     !     !     !     !     !     !     !     !     !     !     !     !     ! Date   R/S   Sun
        Moon  set  2400 1700  1800  1900  2000  2100  2200  2300  2400  0100  0200  0300  0400  0500  0600  0700  0800        Moon  rise
```

(....) indicates Sun above horizon

(XXXX) indicates Moon below horizon

(0000) indicates Moonlight Level less than .003 lux and moon not 23% illuminated or not 30 deg above horizon or neither

(   ) indicates Moonlight Level greater than or equal to .003 lux but moon not 23% illuminated or not 30 deg above horizon

(----) indicates the Moon is at least 23 percent illuminated and at least 30 degrees above the horizon

************************************ Data provided by U.S. Army Aeromedical Research Laboratory **

** Light level planning calender , Clear sky condition **

Latitude N 29 degrees 22 minutes   Longitude E 48 degrees 0 minutes

1 April 1991 to 30 April 1991

```
For    Moon   Sun  %Mn@ 1700 1800 1900 2000 2100 2200 2300 2400 0100 0200 0300 0400 0500 0600 0700 0800 For     Moon  Sun
PM on  R/S    set  2400  !    !    !    !    !    !    !    !    !    !    !    !    !    !    !    ! AM on   R/S   rise
 1 Apr R2021 1806  93%  .......XXXXXXXXXXXXXXOO                  ----------------------------          ............... 2 Apr S0705 537
 2 Apr R2119 1807  87%  .......XXXXXXXXXXXXXXXXXXXOOO                    -----------------------       ............... 3 Apr S0746 536
 3 Apr R2215 1807  80%  .......XXXXXXXXXXXXXXXXXXXXXXXXXXOOOO                  --------------------    ............... 4 Apr S0832 535
 4 Apr R2308 1808  72%  .......XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOO                 ----------------................ 5 Apr S0921 534
 5 Apr R2357 1808  63%  .......XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO                ------------................ 6 Apr S1014 533
 6 Apr none  1809  54%  .......XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO               ----------................ 7 Apr R0042 532
 7 Apr none  1809  44%  .......XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOO             -------................ 8 Apr R0122 531
 8 Apr S1204 1810  35%  .......XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOOOOO          ----................ 9 Apr R0159 529
 9 Apr S1301 1811  26%  ........XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOOOOOOOO--................ 10 Apr R0232 528
10 Apr S1358 1811  18%  ........XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOOOOOOOO................ 11 Apr R0304 527
11 Apr S1456 1812  10%  ........XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOOOOO................ 12 Apr R0336 526
12 Apr S1555 1812   5%  ........XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOO................ 13 Apr R0408 525
13 Apr S1657 1813   1%  ........XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO................ 14 Apr R0442 524
14 Apr S1801 1814   0%  ........XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXO................ 15 Apr R0520 523
15 Apr S1908 1814   2%  ........OOOOOXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX................ 16 Apr R0603 522
16 Apr S2017 1815   6%  ........OOOOOOOOOOOOXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX................ 17 Apr R0652 521
17 Apr S2125 1815  13%  ........OOOOOOOOOOOOOOOOOOOOXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX................ 18 Apr R0749 520
18 Apr S2231 1816  21%  ........     OOOOOOOOOOOOOOOOOOOOOOOXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX................ 19 Apr R0852 518
19 Apr S2329 1817  31%  ........----------------          OOOOOOOOOOOOXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX................ 20 Apr R0959 517
20 Apr none  1817  43%  ........----------------------           OOOOOOOOXXXXXXXXXXXXXXXXXXXXXXXXXXXXX................ 21 Apr S0020 516
21 Apr none  1818  54%  ........--------------------------           OOOOOOXXXXXXXXXXXXXXXXXXXXXXXXXX................ 22 Apr S0104 515
22 Apr R1212 1818  65%  ........------------------------------          OOOOOXXXXXXXXXXXXXXXXXXXXXXX................ 23 Apr S0142 514
23 Apr R1315 1819  75%  ........----------------------------------          OOOXXXXXXXXXXXXXXXXXXX................ 24 Apr S0217 513
24 Apr R1416 1820  84%  ........-------------------------------------          OOOXXXXXXXXXXXXXXXX................ 25 Apr S0249 512
25 Apr R1515 1820  91%  ........----------------------------------------          OOXXXXXXXXXXXXX................ 26 Apr S0320 511
26 Apr R1613 1821  96%  .........   ----------------------------------------        OOXXXXXXXXXX................ 27 Apr S0352 511
27 Apr R1711 1821  99%  .........          ----------------------------------        OXXXXX................. 28 Apr S0425 510
28 Apr R1809 1822 100%  .........                 ------------------------------         O................. 29 Apr S0502 509
29 Apr R1907 1823  99%  .........XXXXOO                  --------------------------      ................. 30 Apr S0542 508
 Date   R/S   Sun  %Mn@  !    !    !    !    !    !    !    !    !    !    !    !    !    !    !    ! Date   R/S   Sun
        Moon  set  2400 1700 1800 1900 2000 2100 2200 2300 2400 0100 0200 0300 0400 0500 0600 0700 0800       Moon  rise
```

(....) indicates Sun above horizon
(XXXX) indicates Moon below horizon
(OOOO) indicates Moonlight Level less than .003 lux and moon not 23% illuminated or not 30 deg above horizon or neither
(   ) indicates Moonlight Level greater than or equal to .003 lux but moon not 23% illuminated or not 30 deg above horizon
(----) indicates the Moon is at least 23 percent illuminated and at least 30 degrees above the horizon

************************************ Data provided by U.S. Army Aeromedical Research Laboratory ************************************

```
**************************************** Light level planning calender , Clear sky condition ******************************************
                              Latitude N 29 degrees 22 minutes    Longitude E 48 degrees 0 minutes

                                              1 May 1991  to  31 May 1991

 For   Moon  Sun  %Mn@ 1700  1800  1900  2000  2100  2200  2300  2400  0100  0200  0300  0400  0500  0600  0700  0800 For   Moon  Sun
 PM on  R/S  set  2400  !     !     !     !     !     !     !     !     !     !     !     !     !     !     !     ! AM on  R/S  rise
  1 May R2059 1824  92%  .........XXXXXXXXXXXXXXXX000                   ---------------------         ...................  2 May S0714  506
  2 May R2150 1825  86%  .........XXXXXXXXXXXXXXXXXXXXXXX0000                 ---------------------    ...................  3 May S0806  505
  3 May R2236 1825  78%  .........XXXXXXXXXXXXXXXXXXXXXXXXXXXX0000                  --------------------...................  4 May S0860  504
  4 May R2318 1826  70%  .........XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX00000                 -----------------...................  5 May S0955  504
  5 May R2355 1826  61%  .........XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX00000               ---------------...................  6 May S1050  503
  6 May none  1827  52%  .........XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX0000000              ------------...................  7 May R0029  502
  7 May none  1828  42%  .........XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX0000000             ----------...................  8 May R0101  501
  8 May S1242 1828  32%  .........XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX0000000000       --------...................  9 May R0132  500
  9 May S1335 1829  23%  .........XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX00000000000000000................... 10 May R0204  460
 10 May S1438 1830  14%  .........XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX000000000000000................... 11 May R0236  459
 11 May S1541 1830   8%  .........XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX0000000000................... 12 May R0312  458
 12 May S1646 1831   3%  ..........XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX000000................... 13 May R0353  458
 13 May S1755 1832   0%  ..........XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX0................... 14 May R0440  457
 14 May S1906 1832   1%  ..........000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX................... 15 May R0535  456
 15 May S2015 1833   4%  ..........0000000000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX................... 16 May R0638  456
 16 May S2118 1833  10%  ..........0000000000000000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX................... 17 May R0746  455
 17 May S2214 1834  19%  ..........0000000000000000000000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX................... 18 May R0856  455
 18 May S2302 1835  29%  ..........------------  0000000000000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX................... 19 May R1004  454
 19 May S2343 1835  39%  ..........----------------         00000000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX................... 20 May R1109  454
 20 May none  1836  51%  ..........--------------------         00000XXXXXXXXXXXXXXXXXXXXXXXXXXXX................... 21 May S0019  453
 21 May R1211 1836  61%  ..........-----------------------         00000XXXXXXXXXXXXXXXXXXXXXXXX................... 22 May S0051  453
 22 May R1310 1837  71%  ..........--------------------------        0000XXXXXXXXXXXXXXXXXXXXXX................... 23 May S0123  452
 23 May R1408 1838  80%  ..........-----------------------------        000XXXXXXXXXXXXXXXXXXX................... 24 May S0154  452
 24 May R1505 1838  88%  ..........-------------------------------        000XXXXXXXXXXXXXXXX................... 25 May S0226  451
 25 May R1603 1839  93%  ..........  --------------------------------       000XXXXXXXXXXXXX................... 26 May S0301  451
 26 May R1700 1839  97%  ..........         ---------------------------         0XXXXXXXX................... 27 May S0340  451
 27 May R1757 1840 100%  ..........                -----------------------          0XXX................... 28 May S0422  450
 28 May R1852 1840 100%  ..........XX0                 ---------------------         ................... 29 May S0509  450
 29 May R1944 1841  98%  ...........XXXXXX00                --------------------       ................... 30 May S0560  450
 30 May R2032 1842  95%  ...........XXXXXXXXXXX00               ----------------------   ................... 31 May S0653  449
 Date   R/S  Sun  %Mn@  !     !     !     !     !     !     !     !     !     !     !     !     !     !     !     ! Date  R/S   Sun
       Moon  set  2400 1700  1800  1900  2000  2100  2200  2300  2400  0100  0200  0300  0400  0500  0600  0700  0800      Moon  rise

(....) indicates Sun above horizon
(XXXX) indicates Moon below horizon
(0000) indicates Moonlight Level less than .003 lux and moon not 23% illuminated or not 30 deg above horizon or neither
(    ) indicates Moonlight Level greater than or equal to .003 lux but moon not 23% illuminated or not 30 deg above horizon
(----) indicates the Moon is at least 23 percent illuminated and at least 30 degrees above the horizon


************************************* Data provided by U.S. Army Aeromedical Research Laboratory **************************************
```

** Light level planning calender , Clear sky condition **

Latitude N 29 degrees 22 minutes   Longitude E 48 degrees 0 minutes

I June 1991 to 30 June 1991

```
  For   Moon  Sun  %Mn@ 1700  1800  1900  2000  2100  2200  2300  2400  0100  0200  0300  0400  0500  0600  0700  0800 For   Moon  Sun
 PM on   R/S  set  2400 !     !     !     !     !     !     !     !     !     !     !     !     !     !     !     ! AM on   R/S  rise
  1 Jun R2154 1843  84% ...........XXXXXXXXXXXXXXXXXXX000             ------------------------.................... 2 Jun S0843 449
  2 Jun R2229 1843  76% ...........XXXXXXXXXXXXXXXXXXXXXX0000             ---------------------.................... 3 Jun S0938 449
  3 Jun R2301 1844  67% ...........XXXXXXXXXXXXXXXXXXXXXXXXXX0000           -------------------.................... 4 Jun S1033 449
  4 Jun R2331 1844  58% ...........XXXXXXXXXXXXXXXXXXXXXXXXXXXXX00000         -----------------.................... 5 Jun S1128 448
  5 Jun none  1845  48% ...........XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX000000        --------------.................... 6 Jun R0001 448
  6 Jun S1224 1845  38% ...........XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX00000000      -----------.................... 7 Jun R0032 448
  7 Jun S1323 1846  27% ...........XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX0000000000000  --------.................... 8 Jun R0106 448
  8 Jun S1425 1846  18% ...........XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX000000000000000000.................... 9 Jun R0143 448
  9 Jun S1532 1846  10% ...........XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX00000000000000.................... 10 Jun R0227 448
 10 Jun S1641 1847   4% ...........XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX000000000.................... 11 Jun R0318 448
 11 Jun S1751 1847   1% ...........XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX000.................... 12 Jun R0417 448
 12 Jun S1859 1848   0% ...........0XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX.................... 13 Jun R0524 448
 13 Jun S2000 1848   3% ...........0000000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX.................... 14 Jun R0635 448
 14 Jun S2053 1848   8% ...........000000000000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX.................... 15 Jun R0747 448
 15 Jun S2139 1849  16% ...........00000000000000000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX.................... 16 Jun R0856 448
 16 Jun S2218 1849  26% ...........-------00000000000000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX.................... 17 Jun R1002 448
 17 Jun S2253 1849  36% ...........-----------     000000000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX.................... 18 Jun R1104 448
 18 Jun S2325 1850  47% ...........--------------        000000XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX.................... 19 Jun none  449
 19 Jun S2357 1850  57% ...........----------------          00000XXXXXXXXXXXXXXXXXXXXXXXXXXXXX.................... 20 Jun none  449
 20 Jun none  1850  67% ...........-------------------           0000XXXXXXXXXXXXXXXXXXXXXXXXXX.................... 21 Jun S0029 449
 21 Jun R1359 1850  76% ...........---------------------             0000XXXXXXXXXXXXXXXXXXXXXX.................... 22 Jun S0103 449
 22 Jun R1456 1851  84% .............----------------------              000XXXXXXXXXXXXXXXXXXX.................... 23 Jun S0140 449
 23 Jun R1552 1851  91% ............ ------------------------                 000XXXXXXXXXXXXXX.................... 24 Jun S0221 450
 24 Jun R1648 1851  95% ............       ----------------------                  00XXXXXXXXXX.................... 25 Jun S0306 450
 25 Jun R1741 1851  99% ............             --------------------                    0XXXXXX.................... 26 Jun S0355 450
 26 Jun R1830 1851 100% ............                  ---------------------                   X.................... 27 Jun S0448 450
 27 Jun R1915 1851  99% ............XXC                  -------------------------             .................... 28 Jun S0543 451
 28 Jun R1955 1851  97% ............XXXXXXOO                ----------------------------       .................... 29 Jun S0638 451
 29 Jun R2031 1851  93% ............XXXXXXXXXXOO             ---------------------------------- ................... 30 Jun S0733 451
 Date   R/S  Sun  %Mn@ !     !     !     !     !     !     !     !     !     !     !     !     !     !     !     ! Date   R/S  Sun
       Moon  set  2400 1700  1800  1900  2000  2100  2200  2300  2400  0100  0200  0300  0400  0500  0600  0700  0800      Moon  rise
```

(. . .) indicates Sun above horizon
(XXXX) indicates Moon below horizon
(0000) indicates Moonlight Level less than .003 lux and moon not 23% illuminated or not 30 deg above horizon or neither
(   ) indicates Moonlight Level greater than or equal to .003 lux but moon not 23% illuminated or not 30 deg above horizon
(----) indicates the Moon is at least 23 percent illuminated and at least 30 degrees above the horizon

*************************************** Data provided by U.S. Army Aeromedical Research Laboratory **

SECTION III

NVG TERRAIN FLIGHT

The type of terrain along the flight path should be considered when planning an NVG mission in the desert. This section describes characteristics of the three most prevalent types of terrain in Southwest Asian deserts (scrub, dry lake beds, and sand dunes) and key terrain flight considerations for each.

A. SCRUB DESERT TERRAIN

CHARACTERISTICS

- Light-colored sand with low, uneven surface.
- Single dune may occur in isolation within scrub.
- Sparse to medium vegetation consisting of small trees, bushes, and low-growing plants.
- Areas of loose sand should be expected (especially in bivouac areas and where vehicular traffic has broken the surface).
- Bedouin camps are more frequent in scrub areas than other types of terrain.
- Major visual cues provided by vegetation, vehicle tracks, and camel tracks.

NOE FLIGHT

- Sparsely vegetated areas provide poor visual cues.
- Altitude estimation in sparse scrub difficult without radar altimeter.
- Rolling terrain difficult to detect.
- Transition from moderately to sparsely vegetated areas causes loss of visual cues and contrast.
- Crew coordination and scanning important (uninterrupted scan of flight path essential).
- Medium density vegetation provides good contrast.
- Left (red) position light aids terrain feature detection at low altitudes (see Section VII-C: Position Lights).

CONTOUR FLIGHT

- **Most unforgiving profile.**
- Altitude determination and acquisition of visual cues difficult in sparsely vegetated areas.
- Tend to inadvertently descend to acquire visual cues.
- Frequent altitude callout required.
- Crew coordination and scanning **critical** (uninterrupted scan of flight path essential).
- ATM maximum airspeeds for contour flight **above 80 feet AHO** can be exceeded provided adequate illumination levels exist and associated risks have been considered (see Section V-A: Airspeed Limitations and Section VI: NVG Mission Airspeed and Altitude Planning Figures).

LOW-LEVEL FLIGHT

- Similar to VFR on top/instrument flight due to loss of horizon (caused by sand, dust, haze, or fog).
- Loss of ground visual cues and contrast.
- Crew coordination and scanning important.
- Step down to land (40-50 kts to 80 ft AGL) (see Section V-C: Approach to Visibility Altitude).
- Obstacle clearance assured if map and route reconnaissance conducted.
- ATM maximum airspeeds for low level (AHO) can be exceeded provided adequate illumination levels exist and associated risks have been considered (see Section V-A: Airspeed Limitations and Section VI: NVG Mission Airspeed and Altitude Planning Figures).

B. DRY LAKE BED DESERT TERRAIN

CHARACTERISTICS

- Dark-colored sand with a hard crust, very flat.
- Single dune may occur in isolation within dry lake bed.
- Little if any vegetation.

■ Normally, no loose sand except where vehicle traffic has broken surface.

■ Major visual cues provided by vehicle tracks and surface cracks.

■ Rise in terrain may be very rapid when transitioning to dune area.

■ Loss of visual reference more likely at higher altitudes due to lack of terrain features.

■ Few navigational landmarks.

NOE FLIGHT

■ When less than 20 feet AGL, take care to avoid fences, large oil pipes, etc.

■ Be aware of tendency to unintentionally increase airspeed over flat terrain.

■ Crew coordination and scanning important (uninterrupted scan of flight path essential).

■ Good texture (dark, crusty surface and vehicle tracks).

■ Contrast between lake bed and dune areas is high.

■ Left (red) position light aids terrain feature detection at low altitudes (see Section VII-C: Position Lights).

■ Maximum ATM NOE airspeed is attainable (knowledge of highest obstacle and location of terrain transition required).

CONTOUR FLIGHT

■ **Most unforgiving profile.**

■ Crew coordination and scanning **critical** (uninterrupted scan of flight path essential).

■ Altitude estimation without radar altimeter difficult.

■ Frequent altitude callout is required.

■ Transition to other terrain hazardous if not anticipated.

■ Be aware of tendency to unintentionally descend to better acquire visual cues.

■ Vehicle tracks and ground texture provide visual cues but are harder to detect at contour level than at NOE.

■ ATM maximum airspeeds for contour flight **above 80 feet AHO** can be exceeded provided adequate illumination levels exist and associated risks have been considered (see Section V-A: Airspeed Limitations and Section VI: NVG Mission Airspeed and Altitude Planning Figures).

LOW-LEVEL FLIGHT

■ Similar to VFR on top/instrument flight due to loss of horizon (caused by sand, dust, haze, or fog) and false horizon (caused by light-colored sand surrounding lake bed blending in with night sky).

■ Loss of ground visual cues and contrast.

■ Obstacle clearance assured if map and route reconnaissance conducted.

■ Crew coordination and scanning important.

■ Step down to land (40-50 kts to 80 ft AGL) (see Section V-C: Approach to Visibility Altitude).

■ ATM maximum airspeeds for low level (AHO) can be exceeded provided adequate illumination levels exist and associated risks have been considered (see Section V-A: Airspeed Limitations and Section VI: NVG Mission Airspeed and Altitude Planning Figures).

C. SAND DUNE DESERT TERRAIN

CHARACTERISTICS

■ Light- to medium-colored sand.

■ Windward side: gradual convex slope.

■ Leeward side: sharp concave wall.

■ Single dune may occur in isolation within either scrub or dry lake bed.

■ Vegetation is sparse to nonexistent.

■ Many large areas contain no terrain features.

■ Camel/vehicle tracks and wind ripples in the sand may be found in low ground between dunes and provide good visual cues.

SPECIAL NOTES ON SAND DUNE AREAS

■ *Stay out* (avoid if possible).

■ If avoidance is not possible—

•*Do not* fly straight line over dunes in NOE or contour flight modes. Maneuver around rather than over dunes.

•As you enter the dunes, plan an approach to an area in dunes with definition and contrast as in a confined area operation. After the approach, establish visual contact with the ground before proceeding on the planned route.

■ Loose sand can be expected everywhere in dunes.

NOE FLIGHT

■ **If required to operate in the dunes—**

• Maneuver around rather than over dunes. Straight-line NOE flight **extremely hazardous.**

• WARNING: **Anticipate frequent occurrence of deadends in pathways through dune areas.**

• As you enter the dunes, plan an approach to an area in dunes with definition and contrast as in a confined area operation. After the approach, establish visual contact with the ground before proceeding on the planned route.

■ Airspeeds:

• Airspeeds **lower** than ATM NOE **maximums** required during periods of low illumination (see Section VI: NVG Mission Airspeed and Altitude Planning Figures).

• Recommend airspeed above ETL to stay clear of rotor-induced blowing sand.

■ Crew coordination and scanning important (uninterrupted scan of flight path essential).

■ Visual cues at NOE:

• Camel and vehicle tracks.

• Wind ripples in the sand.

• Slope of surrounding dunes.

• Some brush.

• Contrast between dry lake bed and dunes.

■ Left (red) position light aids terrain feature detection at low altitudes (see Section VII-C: Position Lights).

CONTOUR FLIGHT

■ **Most unforgiving profile. NOT RECOMMENDED but if necessary—**

• Contour **below 80 feet** AHO—Maneuver around rather than over dunes.

• Contour **above 80 feet** AHO—Traverse at 100 feet AHO and travel shortest distance through area.

• **WARNING: Knowledge of highest obstacle (sand dune) required but remember dune height may change due to blowing sand.**

■ Altitude determination very difficult due to loss of most ground visual cues.

■ May require reference to basic flight instruments.

■ Radar altimeter **a must.** (Pilots have been observed to misjudge altitude by plus or minus 70 feet without use of radar altimeter.)

■ Frequent altitude callout required.

■ Crew coordination and scanning **critical** (uninterrupted scan of flight path essential).

LOW- LEVEL FLIGHT

■ Similiar to VFR on top/instrument flight due to loss of horizon (caused by sand, dust, haze, or fog).

■ Loss of ground visual cues and contrast.

■ Frequent altitude callout required due to difficulties in determining altitude.

■ Obstacle clearance assured if map and route reconnaissance conducted.

■ If required to land, **extreme caution** must be exercised (see Section V-C: Approach to Visibility Altitude).

■ Crew coordination and scanning important.

■ ATM maximum airspeeds for low level (AHO) can be exceeded provided adequate illumination levels exist and associated risks have been considered (see Section V-A: Airspeed Limitations and Section VI: NVG Mission Airspeed and Altitude Planning Figures).

D. TERRAIN TRANSITION

TERRAIN TRANSITION IDENTIFICATION

■ Route reconnaissance should be performed, if possible, and hazard maps developed that identify transition areas.

■ *Transition characteristics.*

• Terrain transitions can be identified by watching for changes in contrast, texture, and other visual cues.

❑ Change to light-colored sand without vegetation indicates you may be entering a sand dune area.

❑ Change to dark, crusty surface without vegetation indicates you may be entering dry lake bed area.

❑ Change to sparse vegetation indicates

you may be entering or leaving scrub area.

■ *Identification during various flight modes.*

• Contour **above 80 feet AHO** and low level flight: Best mode of flight for early identification of transition areas and obstacle avoidance.

• Contour flight **below 80 feet AHO**: Transition may be abrupt and obstacle avoidance **is not** assured when transitioning to scrub-free sand or dunes. **Most unforgiving profile.**

• NOE: Transition will be obvious but may be abrupt. Obstacle avoidance is **not** assured. Slow airspeed and low altitude provide best visual cues and reaction time.

PROBLEMS ENCOUNTERED

■ At NOE and contour flight altitudes, visual cues may start to become obscure. When this occurs, the pilot must decide to either—

• Go lower and slower. This provides for acquisition of visual cues and increases reaction time; however, obstacle avoidance is **not** assured.

OR

• Climb. This will increase probability of obstacle avoidance. However, visual contact with the ground will be degraded or lost. If contact is lost, the unit's plan for re-establishment of ground reference should be executed.

■ The amount of illumination, contrast, and obscuration, as well as position of the moon, can affect the distance at which you can see (and react to) terrain transition.

■ Transition from high to low contrast (dark to light sand, scrub to non-scrub) is most difficult due to loss of visual cues:

• Dry lake bed (dark) transitioning to flat sand or dunes (light).

• Scrub transitioning to flat sand or dunes.

■ *Transition to dune area.* As you enter the dunes, plan an approach to an area in dunes with definition and contrast as in a confined area operation. After the approach, establish visual contact with the ground before proceeding on the planned route.

SECTION IV

VISUAL ILLUSIONS

It is critical that pilots be familiar with visual illusions that may affect safe NVG flight. Each visual illusion listed in Chapter 1 of TC 1-204 can occur in the desert environment. Discussed below are the illusions most frequently encountered in Southwest Asia and ways to overcome them.

A. FALSE HORIZON OR LACK OF HORIZON

DESCRIPTION. Correct identification of real horizon may be hindered by—

- False horizon created by light-colored area surrounding dark area blending with night sky (e.g., sand dunes bordering dry lake bed).
- Sand, dust, haze, or fog obscuring the horizon.

HOW TO COMBAT

- Cross-check attitude indicator and increase scan for identification of reliable visual cues.
- Direct assistance from crewmembers to correctly identify horizon.

B. HEIGHT PERCEPTION ILLUSION

DESCRIPTION. Sensation of being higher or lower than you actually are due to poor contrast and lack of visual references. This may result in a tendency to inadvertently descend to acquire visual cues.

HOW TO COMBAT

- Cross-check radar or barometric altimeter.
- Direct assistance from crewmembers for altitude determination.
- Decelerate, then descend slowly to obtain visual cues.
- Look for any shadows cast by near objects.
- Drop chemical stick for ground reference.

C. GROUND LIGHT MISINTERPRETATION

DESCRIPTION. Confusing ground lights with stars or other aircraft. When ground lights are confused with stars, aviators unknowingly position the aircraft in unusual attitudes to keep ground lights (believed to be stars) above the aircraft. When ground lights are confused with other aircraft, aviators adjust attitude incorrectly based on relative position of misinterpreted ground light.

HOW TO COMBAT

- Check attitude indicator.
- Direct crewmember assistance to confirm source of light and aircraft attitude.
- Increase scan for more reliable cues on aircraft attitude and source of light.

D. FIXATION

DESCRIPTION. Fixing attention on high interest targets/objects and ignoring orientation cues. This results in missing cues critical to safe flight such as aircraft-ground closure rate.

HOW TO COMBAT

- Be aware of the tendency to stare at high interest targets.
- Do not stare at any location/point for more than 2 or 3 seconds.
- Increase frequency of scan.
- Direct crew assistance.

E. CRATER ILLUSION (not discussed in TC 1-204)

DESCRIPTION. Viewing the periphery of the IR band-pass filter (pink light) or IR searchlight gives the illusion that flat terrain slopes upward. Viewing another aircraft landing using the pink light or IR searchlight can give the illusion that the observed aircraft is descending into a crater when the terrain is actually flat.

HOW TO COMBAT

- Knowledge and awareness of the illusion.
- Conduct thorough map and route reconnaissance to identify terrain features/contour.
- Conduct high and low recon prior to landing.
- Sweep searchlight laterally for terrain cues.
- Scan past pink light limits.

F. LACK OF MOTION PERCEPTION (MOTION PARALLAX)

DESCRIPTION. At low level flight mode altitudes, the lack of discernible terrain features may result in perception of near zero groundspeed.

HOW TO COMBAT

- Refer to airspeed indicator. (NOTE: Airspeed indicators are typically unreliable below 20 kts IAS.)
- Direct crewmember assistance for airspeed callout.

SECTION V

NVG MISSION PLANNING

Planning for NVG missions includes all daytime planning considerations but must be more detailed. Extra planning time must be provided whenever possible. The following are planning considerations specific to Southwest Asia.

A. AIRSPEED LIMITATIONS

NOE & CONTOUR ALTITUDES BELOW 80 FEET AHO. Airspeed limitations for NVG missions specified by each individual aircraft ATM shall not be exceeded.

CONTOUR & LOW LEVEL ALTITUDES ABOVE 80 FEET AHO

■ Mission demands may dictate a faster airspeed than currently listed in the ATM.

■ Exceeding ATM airspeeds **above 80 feet AHO** is authorized *provided* commanders consider the associated risks. Faster airspeed is mission, enemy, terrain, troops, and time (METT-T) dependent. Use of higher airspeeds will increase overall mission risk.

■ **CAUTION:** Higher airspeeds may cause the aviator to exceed his capability to detect and avoid obstacles.

■ Visual contact with terrain is preferred for orientation, but may be degraded or lost at altitudes above 80 feet AHO.

B. PHASES OF FLIGHT

TAKEOFF

■ Assume that conditions for brownout exist and may be amplified by other aircraft operating in close proximity.

■ Minimize obscuration by accelerating above ETL as quickly as practicable, or using altitude over airspeed technique.

■ Increased crew coordination and scanning is required (see Section VIII: Crew Coordination & Scanning).

EN ROUTE

■ A thorough route reconnaissance (map, intelligence, scout, etc.) is **essential** to reduce risk within the flight corridor/route.

■ In addition to basic METT-T and NVG specific METT-T considerations (see Section IX-D), the following are significant factors in determining mission airspeeds:

- Illumination levels.
- Obstacles.
- Number and type of aircraft.
- Aircraft exterior lighting.

■ NVG mission airspeed and altitude planning figures in Section VI—

- Should be used by the commander to aid in determining altitudes AHO and maximum airspeeds over different types of terrain.
- Should be used in risk assessment, training, and operational planning.
- Do not represent all types of terrain that may be encountered.
- Should not be construed as regulatory in nature.
- Should not be used until familiar with the precautions and directions for use discussed in Sections VI-A & B.

■ Transitioning from the faster en route airspeeds to lower airspeeds in contour, NOE, and landing configurations requires detailed planning (see sections on "Landing" and "Approach to Visibility Altitude" below).

LANDING

■ Landing zones.

- An area should be identified that has minimal loose dirt/sand, if possible.

• A crosswind landing that allows for increased visibility may benefit a formation.

• If more than one sortie into the same LZ/PZ is expected, the first flight of aircraft into the area could set up an inverted "Y", using clear bottles of water with chemical sticks inside.

• CH-47s may require close-in "Y" and far-out "T" to maintain hover position in the LZ/PZ.

• If available, **Pathfinders** should be used to direct aircraft.

■ Approach to landing zones.

• Prior to conducting mission, it is important to determine the distance from the LZ/PZ that an aircraft or formation should start decelerating. (**KEY** is to gradually slow down.)

❑ When traveling as single aircraft or in a small formation, deceleration should begin approximately 3 to 5 kilometers from the LZ/PZ.

❑ Larger formations should begin deceleration approximately 5 to 8 kilometers from the LZ/PZ.

❑ RULE OF THUMB—Decrease airspeed 20 knots per kilometer.

• Descents should be gradual:

❑ Avoid rapid changes in altitude.

❑ Rapid changes in airspeed may degrade pilots' viewing perspective outside aircraft or induce spatial disorientation.

• Best landing procedure is shallow approach angle and touchdown with slight forward movement. If disorientation occurs at any time during the approach, apply power and execute a go-around. If go-around is not feasible, attempt to maneuver the aircraft forward and down to limit the possibility of touchdown with sideward or rearward movement.

• During the approach it is essential that crewchiefs/observers call out location of the dust cloud and the ground in relation to the aircraft.

■ Rate of descent, altitude, and drift should be constantly monitored.

C. APPROACH TO VISIBILITY ALTITUDE

■ When descending from altitudes above 100 feet AHO, the pilot should slowly step down to an altitude where visual ground reference can be acquired and maintained, then execute an approach from that altitude.

■ Altitude of approximately 80 feet has been determined to be sufficient for gaining ground reference in most situations. This altitude will vary with terrain type, illumination, and obscuration.

■ Recommend that an approach airspeed less than cruise (perhaps as slow as 40-50 kts) be maintained until reaching the visibility altitude.

■ Monitor rate of descent using VSI.

D. HOVER OGE

■ One of the most demanding maneuvers in the desert, especially with limited illumination and visual cues.

■ Pilot on the flight controls **must** maintain visual reference with the ground throughout this maneuver.

■ Radar altimeter is **critical**, and continuous callouts by pilot not on the flight controls is required (see Section VIII: Crew Coordination & Scanning).

■ Some types of aircraft (e.g., CH-47, UH-60) may experience brownout conditions as high as 60 feet AGL during OGE maneuvers.

SECTION VI

NVG MISSION AIRSPEED AND ALTITUDE PLANNING FIGURES

The figures below provide altitude and airspeed *recommendations* **(clear nights)** developed for three prevalent types of terrain in Southwest Asia under various levels of moon illumination. These figures do not represent all types of terrain that may be encountered and *should not be construed as regulatory in nature.*

A. IMPORTANT PRECAUTIONS

The following are points to keep in mind when using the figures below to plan NVG missions.

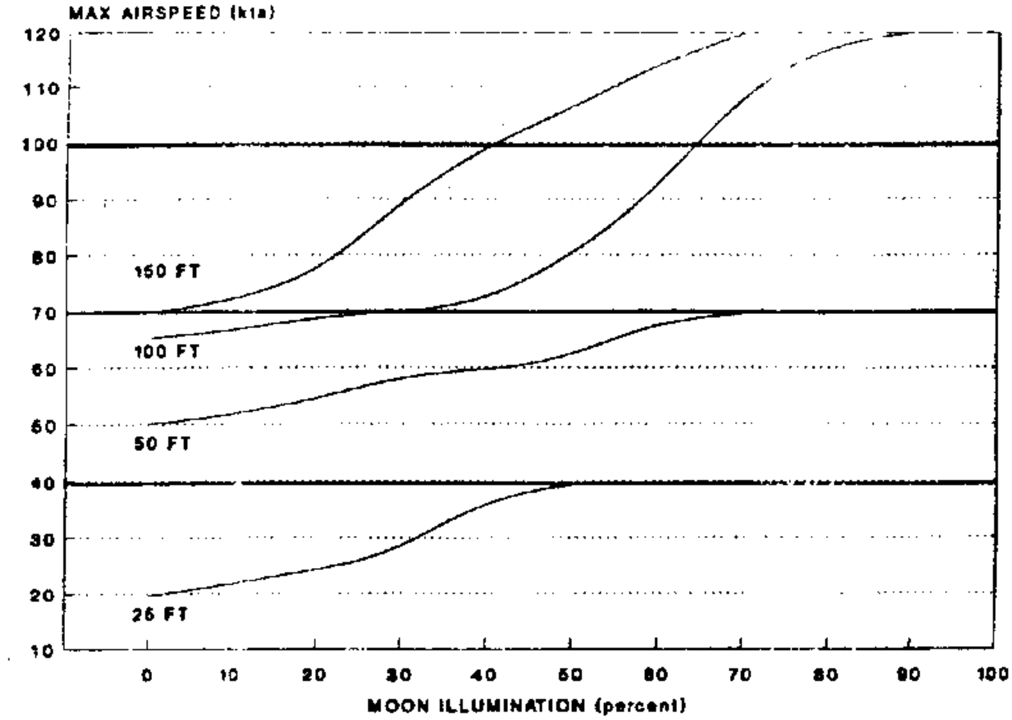
NO SAFETY MARGIN IS INCLUDED IN FIGURES.

- Knowledge of highest obstacle is **required.**
- Airspeeds presented in figures are **RECOMMENDED MAXIMUMS.** Airspeeds must be chosen with consideration of crew experience and mission demands.
- Maximum airspeed data are based on test flights in UH-1 aircraft using highly experienced instructor pilots.
- Response time of aircraft will vary with gross weight and density altitude.

B. USE OF FIGURES

- Figures are provided for three terrain types (scrub, dry lake bed, and sand dunes). Each figure shows maximum recommended airspeeds for four altitudes representing NOE, contour, and low-level flight according to the amount of moon illumination present.
  - The horizontal axis is percent of the moon illuminated (assumes moon angle 60 degrees or more above horizon).
  - The vertical axis is maximum airspeed for safe flight over the indicated terrain type. *(No safety margin included.)*
  - ATM airspeed limits for NOE, contour, and low-level flight modes (40, 70, and 100 kts) are indicated by dark horizontal lines.
  - Curved lines representing maximum airspeeds are plotted for each of four altitudes that correspond roughly to the three modes of terrain flight (NOE at 25 feet or less, contour at 50 and 100 feet, and low level at 150 feet).
  - Important points about each mode of flight for each terrain are included below the figure (also see Section III: NVG Terrain Flight).

TERRAIN: SCRUB



EXAMPLE: AT 20% ILLUM - PLANNED NOE FLIGHT (25') - MAX SAFE A/S = 25 KTS

- FUNCTIONS REPRESENT MAXIMUM RECOMMENDED AIRSPEED WITH NO SAFETY MARGIN
- DATA DERIVED FROM UH-1H (WITH RADAR ALTIMETER) AT MOON ANGLES ABOVE 60 DEGREES WITH REPORTED VISIBILITY IN EXCESS OF 7 MILES
- DATA MAY NOT BE REPRESENTATIVE OF ALL TYPES OF SCRUB TERRAIN
- ALL ALTITUDES ARE AHO

NOE:

- VEGETATION PROVIDES RELIABLE CUES
- ROLLING TERRAIN DIFFICULT TO PERCEIVE
- ALTITUDE ESTIMATION IN SPARSE SCRUB DIFFICULT

CONTOUR:

- MOST UNFORGIVING FLIGHT PROFILE
- TENDENCY TO INADVERTENTLY DESCEND TO ACQUIRE VISUAL CUES
- FREQUENT ALTITUDE CALL-OUT IS REQUIRED
- CREW COORDINATION AND SCANNING CRITICAL
- TRANSITION TO OTHER TERRAIN HAZARDOUS IF NOT ANTICIPATED (SEE SECTION III-D)

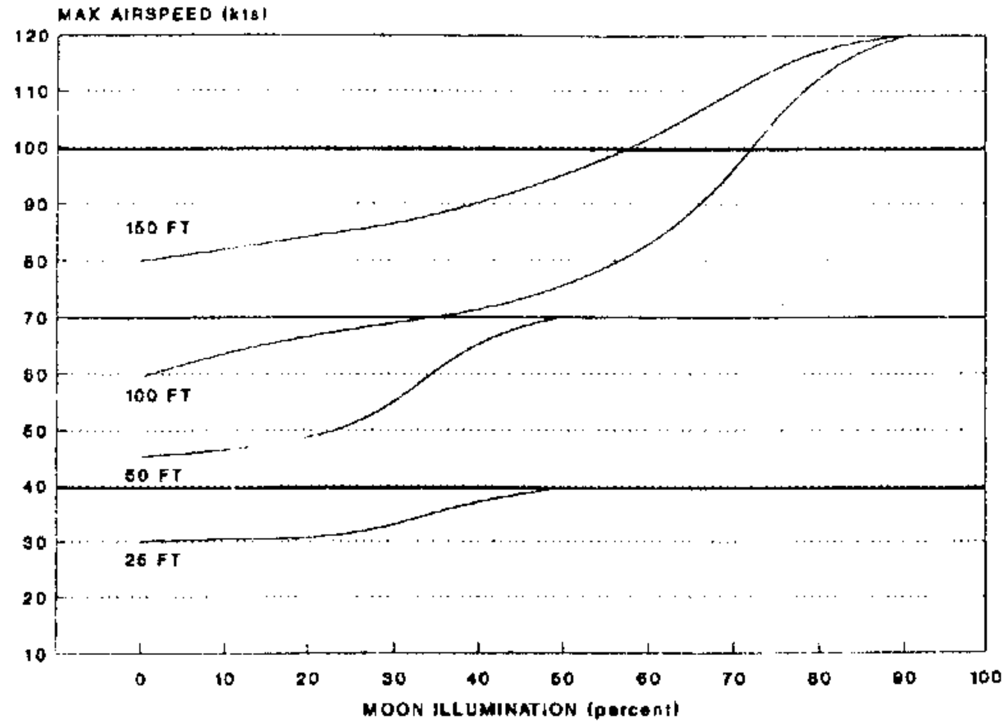
LOW LEVEL:

- MOST GROUND VISUAL CUES LOST
- MAY REQUIRE REFERENCE TO BASIC FLIGHT INSTRUMENTS
- DESCENT TO VISIBILITY ALT REQUIRED FOR APPROACH/LANDING (SEE SECTION V-C)

OTHER PLANNING CONSIDERATIONS:

- MOON POSITION (SEE SECTION II-A)
- USE OF A/C LIGHTING (SEE SECTION VII-B & C)
- VISUAL ILLUSIONS (SEE SECTION IV)
- VISUAL CUES FOR TERRAIN TRANSITION (SEE SECTION III-D)

TERRAIN: DRY LAKE BED



EXAMPLE: AT 40% ILLUM--CONTOUR FLIGHT 50' AHO--MAX SAFE A/S = 66 KTS

- FUNCTIONS REPRESENT MAXIMUM RECOMMENDED AIRSPEED WITH NO SAFETY MARGIN
- DATA DERIVED FROM UH-1H (WITH RADAR ALTIMETER) AT MOON ANGLES ABOVE 60 DEGREES WITH REPORTED VISIBILITY IN EXCESS OF 7 MILES
- DATA MAY NOT BE REPRESENTATIVE OF ALL TYPES OF DRY LAKE BED
- ALL ALTITUDES ARE AHO

NOE:

- TENDENCY TO INCREASE AIRSPEED OVER FLAT TERRAIN
- VEHICLE TRACKS AND CRACKS IN LAKE BED PROVIDE RELIABLE CUES
- FEW NAVIGATIONAL LANDMARKS
- CONTRAST BETWEEN LAKE BED AND DUNE AREAS IS HIGH

CONTOUR:

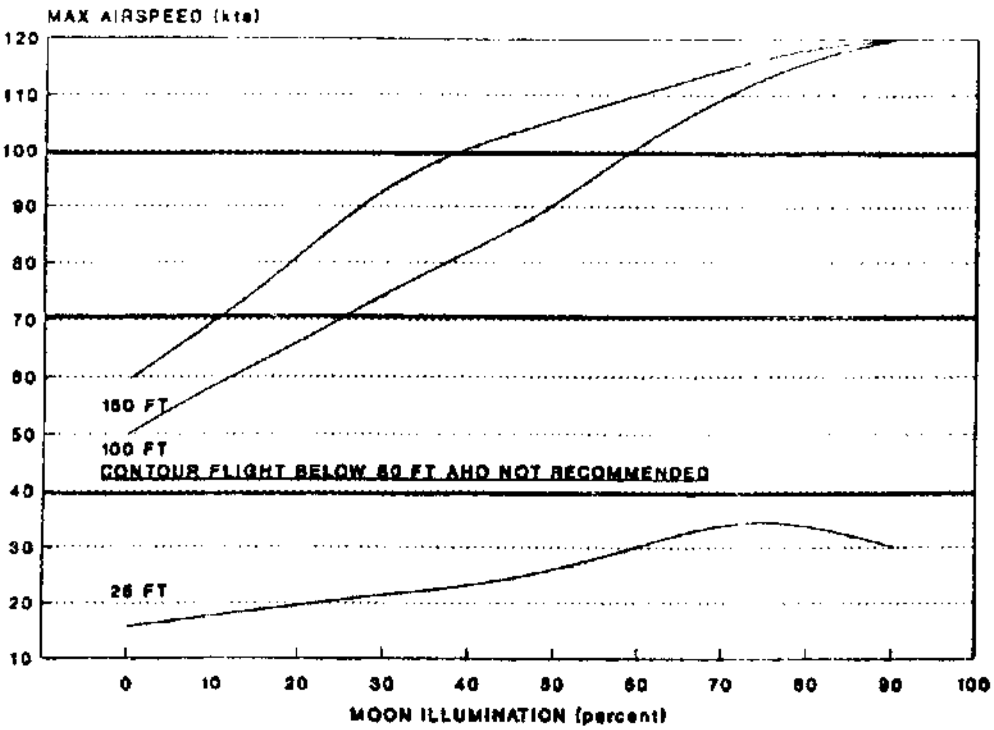
- FREQUENT ALTITUDE CALL-OUT IS REQUIRED
- CREW COORDINATION AND SCANNING CRITICAL
- TENDENCY TO INADVERTENTLY DESCEND TO ACQUIRE VISUAL CUES
- TRANSITION TO OTHER TERRAIN HAZARDOUS IF NOT ANTICIPATED (SEE SECTION III-D)

LOW LEVEL:

- MOST GROUND VISUAL CUES LOST
- MAY REQUIRE REFERENCE TO BASIC FLIGHT INSTRUMENTS
- DESCENT TO VISIBILITY ALT REQUIRED FOR APPROACH/LANDING (SEE SECTION V-C)
- FALSE HORIZONS OCCUR FREQUENTLY (LIGHT-COLORED SAND THAT SURROUNDS LAKE BED BLENDS IN WITH NIGHT SKY)

OTHER PLANNING CONSIDERATIONS:

- MOON POSITION (SEE SECTION II-A)
- USE OF A/C LIGHTING (SEE SECTION VII-B & C)
- VISUAL ILLUSIONS (SEE SECTION IV)
- VISUAL CUES FOR TERRAIN TRANSITION (SEE SECTION III-D)



EXAMPLE: AT 70% ILLUM--PLANNED LOW LEVEL FLT 100' AHO--A/S = 110 KTS

- FUNCTIONS REPRESENT MAXIMUM RECOMMENDED AIRSPEED WITH NO SAFETY MARGIN
- DATA DERIVED FROM UH-1H (WITH RADAR ALTIMETER) AT MOON ANGLES ABOVE 60 DEGREES WITH REPORTED VISIBILITY IN EXCESS OF 7 MILES
- DATA MAY NOT BE REPRESENTATIVE OF ALL TYPES OF DUNE TERRAIN
- ALL ALTITUDES ARE AHO

VISUAL ILLUSIONS OCCUR FREQUENTLY AT ALL ALTITUDES

NOE:

- STRAIGHT-LINE NOE OVER DUNES EXTREMELY HAZARDOUS
- FOLLOW LOW GROUND BETWEEN DUNES: SPARSE SCRUB, VEHICLE AND CAMEL TRACKS PROVIDE GOOD CUES

CONTOUR BELOW 60 FEET AHO NOT RECOMMENDED

CONTOUR ABOVE 60 FEET AHO AND LOW LEVEL:

- MAY REQUIRE REFERENCE TO BASIC FLIGHT INSTRUMENTS
- MOST GROUND VISUAL CUES LOST
- DESCENT TO VISIBILITY ALT NOT RECOMMENDED FOR APPROACH/LANDING. IF REQUIRED, USE EXTREME CAUTION (SEE SECTION V-C)
- PRIOR KNOWLEDGE OF HIGHEST OBSTACLE REQUIRED
- REQUIRES ALTITUDE CALL-OUT WITH INCREASED CREW COORDINATION AND SCANNING

OTHER PLANNING CONSIDERATIONS:

- MOON POSITION (SEE SECTION II-A)
- USE OF A/C LIGHTING (SEE SECTIONS VII-B & C)
- VISUAL ILLUSIONS (SEE SECTION IV)
- VISUAL CUES FOR TERRAIN TRANSITION (SEE SECTION III-D)

SECTION VII

EQUIPMENT

The desert requires a thorough understanding of normal equipment as well as innovations developed specifically for this environment. It is important for crewmembers to know the capabilities and limitations of the following equipment.

A. NAVIGATION

- GPS is the most accurate navigation tool.
- LORAN and OMEGA are next best.
- Doppler is good if update points can be identified.
- Use non-directional beacons available in ATC units and post grid locations as well as latitude and longitude coordinates.
- Other considerations:
    - Aviation-related intelligence must be actively pursued (i.e., to document wires, towers, and terrain relief).
    - Whenever possible, conduct a route reconnaissance.
    - Close attention must be paid to the few contour lines and contour intervals shown on maps.
    - Time, distance, and heading must be used in addition to the above.

B. BAND-PASS FILTER (PINK LIGHT)

- Best altitude for use is approximately 80 feet AGL and below.
- Best bulb is 150w, 7,000cp, P/N 4571, NSN 6240-00-690-1094 (if rheostat light control not available).
- Most effective at near zero illumination levels.
- Can cause terrain washout at illumination percentages of 30% and above.
- Tends to limit pilots' scan to within area of beam spread; a corresponding reduction in airspeed should be considered.
- Pilot may incorrectly infer terrain transition or change in ground slope based on artificial edge produced by beam.
- May cause brownout when used below ETL due to reflection from dust in rotorwash.
- Light- and heat-emitting active source that persists after light is extinguished, providing target for enemy sensors.
- In dusty terrain, avoid brownout by switching off during approach.
- Should be a key training tool (i.e., limitations and advantages need to be demonstrated). Use is dependent on terrain, illumination, and pilot's experience level in-theater.

C. POSITION LIGHTS

- May help maintain terrain reference during approaches with low to medium illumination levels and pink light off.
- Most illumination provided by red position light on left side of aircraft.
- Active source for enemy to detect; can be partially taped to reduce signature.
- IR position lights assist in maintaining aircraft separation during formation flights.

D. RADAR ALTIMETER

- **CAUTION:** Only gives altitude directly beneath aircraft; is not forward-looking (provides no direct measure of terrain ahead).
- Should be required for all flights below 150 feet AGL.
- The most critical flight instrument during contour flight, approaches, and OGE maneuvers. (Pilots have been observed to misjudge altitude by plus or minus 70 feet without use of radar altimeter.)

■ Best way to determine altitude from 25 feet AGL up.

■ Use (altitude callout) should be incorporated into crew coordination drills.

■ Ensure radar altimeter complies with message, DTG 061200Z OCT 87, subject: Night Vision Goggle Operations. No red lighting in cockpit.

■ If radar altimeter is red lit, contact maintenance officer to exchange.

E. NIGHT VISION GOGGLES

■ AN/AVS-6s should be used for all crewmembers when possible (instead of AN/PVS-5s).

■ Care must be taken to keep lenses clean.

■ Must strictly adhere to maintenance requirements.

F. TERRAIN PERCEPTION ENHANCEMENT KIT (TPEK): AIMING LIGHTS

CAUTIONS

■ The TPEK was not designed as an obstacle avoidance system. At high airspeeds, pilot may have little if any response time to react to an obstacle illuminated by the aiming lights.

■ The TPEK is only an aid to flying with ANVIS.

■ If the enemy is using night vision equipment, they may be able to detect the IR light source used in the aiming lights.

■ The TPEK provides additional visual cues only over upsloping terrain.

DESCRIPTION

■ The TPEK includes two infrared (IR) aiming lights mounted on brackets. The aiming light emits an IR light that appears as a visible spot on the terrain or obstacle.

■ The TPEK provides aviators with visual cues of approaching terrain features in the aircraft's flight path. The manufacturer reports obstacle illumination out to a distance of 150 meters. (During NVG evaluation in the Southwest Asian desert, TPEK illuminated obstacles out to a distance of 400 meters.)

ADJUSTMENT

■ As of this publication, a pre-mission flight is required to adjust the aiming lights to the anticipated mission airspeed. Aiming lights **MUST BE RE-ADJUSTED** for airspeed changes. Basic adjustment guidance is found in the Installation/Operation/Maintenance Guide. More detailed instructions are being developed.

■ IF PROPERLY ADJUSTED, when a TPEK-equipped aircraft approaches an object in the flight path, one or both aiming light spots become visible on the object. Two light spots indicate that the aircraft is on a collision course with the object.

OPERATING PRINCIPLES

■ When aimed at a solid object, IR energy is reflected back from the object and is seen as a spot of light through AN/AVS-6s.

■ As the aircraft continues to approach an object, light intensity of the spots increases. The intensity of the spots may provide a relative cue to distance between the aircraft and the obstacle.

■ The TPEK spots also provide cues that allow greater definition of terrain relief (i.e., tops of ridge lines) seen through the ANVIS imager. The pilot using this information surveys the terrain through the ANVIS and, using the TPEK spots as aids, changes aircraft course to avoid collision with objects.

SECTION VIII

CREW COORDINATION AND SCANNING

Effective crew coordination and scanning are critical during desert NVG terrain flight. Basic crew coordination and scanning considerations and procedures are discussed in this section.

A. CREW COORDINATION

DEFINITION. Crew coordination is the interaction between crewmembers (communication) and actions (sequence or timing) necessary for tasks be be performed efficiently, effectively, and safely.

PLANNING. Crewmembers should identify mission and flight requirements that will necessitate effective crew communication and proper sequence or timing of crew actions. They should decide what the crew coordination will be to accomplish these requirements and plan to discuss it during pre-mission brief.

■ EXAMPLE: Contact Task Force Bravo commander after crossing phase line BLACK.

RESPONSIBILITIES

■ PIC assigns crew responsibilities during pre-mission brief.

■ Communications and sequence/timing of actions required to perform mission-related tasks efficiently and safely are discussed with all crewmembers and rehearsed (if necessary).

■ PIC amends responsibilities as necessary during mission.

■ EXAMPLE: PIC directs that when aircraft reaches PL Black, he will take the controls and the copilot will be responsible for changing the radio to TF Bravo command frequency and making an initial contact with TF Bravo commander.

PROCEDURES

■ *Positive Communication:*

• Communication is positive when sender directs/announces/requests, receiver acknowledges, and sender confirms (based on receiver acknowledgment and/or correct action).

• Use positive communication procedure for critical crew coordination actions.

• Communications should employ standard terminology with specific qualification sufficient to ensure understanding.

• EXAMPLE: POC directs PNOC, "Turn on the IR light." PNOC acknowledges, "Roger, IR light on." PNOC's verbal acknowledgment and action of activating IR light serves as POC's confirmation.

■ *Direct Assistance:*

• POC directs assistance from non-flying crewmembers that is necessary for efficient, effective, and safe operation of aircraft.

• EXAMPLE: POC directs PNOC and CE to perform before-landing check.

■ *Announce Decision:*

• Each crewmember announces decisions made or actions planned that affect the performance of duties assigned to other crewmembers.

• EXAMPLE: POC (right side) states, "I'm beginning to lose visual reference at this altitude. I'm descending to maintain visual cues."

■ *Offer Assistance:*

• Each crewmember offers assistance or information that has been requested by the POC or that the crewmember recognizes is needed by the POC.

• EXAMPLE: Continued from the example above—PNOC (left side) clears his area of responsibility and announces "Roger, we're clear down left."

POC=	PNOC=	PIC=	CE=
Pilot on controls	Pilot not on controls	Pilot in command	Crew chief/observer

■ *Action Sequence/Timing:*

•Each crewmember ensures actions taken are properly sequenced and timed with actions of other crewmembers.

•EXAMPLE: POC requests left rear clearance from the CE and does not turn aircraft until clearance has been confirmed by CE.

GENERAL CONSIDERATIONS

■ Use of battle-rostered crews may enhance crew coordination.

■ Standardization of critical crew coordination actions will improve not only efficiency, effectiveness, and safety of mission but should also facilitate training and cross crew assignments.

■ Critical crew coordination procedures should be drilled for emergency situations (e.g., loss of ground reference such as brownout and IMC, visual illusions, engine failure).

■ Sound crew coordination procedures implemented in day operations should facilitate positive habit transfer to night/NVG operations.

■ It is the responsibility of *every* crewmember to advise POC when ground reference is lost or aircraft appears to be in an unsafe condition.

•PNOC must alert POC any time unanticipated deviation from planned airspeed or altitude occurs.

•During approach it is essential that crew chiefs/observers track location of the dust cloud and alert POC if it appears that the aircraft may become engulfed.

■ If POC recognizes that he is experiencing a visual illusion, he should inform other crewmembers.

■ Efficient crew coordination is **critical** below 100 feet AGL.

■ Communication must be clear and concise. Use of standard terminology is recommended and encouraged.

B. SCANNING

RESPONSIBILITIES

■ Scanning responsibilities for each crewmember are presented in the following table.

Crewmember Scanning Responsibilities

Pilot Not On Controls (PNOC)	Pilot On Controls (POC)	Non-Rated Crewmember
GENERAL		
• Provide continuous information on obstacles and terrain trends (e.g., transition, turns). Use clock method.	• Verbally acknowledge obstacles when visual contact is made.	• Provide information on terrain (e.g., obstacles, transition) and other aircraft. Use clock method.
• Announce when leaving sector of scanning responsibility (e.g., when studying map).	• Acknowledge and enlarge scanning sector when PNOC announces stopping outside scan.	• Acknowledge and enlarge scanning sector when either pilot or other crewmember announces he is stopping scan of his sector.
	• If outside scanning is discontinued, transfer controls or coordinate with other crewmembers to ensure obstacle clearance is maintained.	

Pilot Not On Controls (PNOC)	Pilot On Controls (POC)	Non-Rated Crewmember
	NOE	
• Scan for cues at all ranges (close, mid- and far-range). • Provide navigation instructions and feedback regarding airspeed, altitude, descent rate, and system status.	• Primary attention *outside* aircraft (CRITICAL). • Scan priority should be immediate flight path as airspeed increases. • Conduct continuous scan that samples near to mid-range cues within intended course of flight for obstacle avoidance. • Do not fixate.	• Keep attention *outside* (CRITICAL). • Conduct continuous scan of assigned sector for obstacle avoidance. • Provide feedback regarding altitude, attitude, and descent rate.
	CONTOUR	
• Scan for cues at mid- and far range.	• Primary attention *outside* aircraft, scanning immediate flight path (CRITICAL).	• Keep attention *outside* (CRITICAL).
• Provide navigation instructions and feedback regarding airspeed, altitude, descent rate, and system status.	• Scan for near- and mid-range cues for obstacle avoidance.	• Conduct continuous scan of assigned sector for obstacle avoidance.
• Frequent altitude callouts required.	• Do not fixate.	• Provide feedback regarding altitude, attitude, and descent rate.
	LOW LEVEL	
• Scan for cues at mid- and far-range.	• Primary attention outside aircraft.	• Conduct continuous scan of assigned sector for obstacle avoidance.
• Provide navigation instructions and feedback regarding airspeed, altitude, descent rate, and system status.	• Scan for cues at mid- and far-range.	• Provide feedback regarding altitude, attitude, and descent rate.
• Systematically monitor light and dark areas of terrain to identify transitions in terrain type.	• Systematically monitor light and dark areas of terrain to identify transitions in terrain type.	• Systematically monitor light and dark areas of terrain to identify transitions in terrain type.

■ Non-rated crewmembers are key participants in scanning, clearing, and monitoring aircraft attitude and descent rates.

■ Sectors of scanning responsibility must be assigned for each crewmember before flight. Aircraft type should be considered when assigning sectors of scanning.

■ EXAMPLE: In UH-60 pre-mission brief, PIC assigns sectors of scanning responsibility as follows:

a. Left-seat pilot assigned responsibility from center post to approximately 90 degrees left.

b. Right-seat pilot assigned responsibility from center post to approximately 90 degrees right.

c. Non-rated crewmember(s) assigned responsibility to scan left or right approximately 180 degrees.

d. When PNOC announces his intention to stop scanning his assigned sector (e.g., to study map), POC and non-rated crewmember(s) acknowledge and assume responsibility for his scanning sector.

PROCEDURES

■ **Do not allow** scan of aircraft flight path to be interrupted.

■ Crewmembers must rotate head and eyes continuously. Scan should be slow enough to acquire visual cues and not so fast as to induce spatial disorientation. Occasionally, crewmembers may find it necessary to stop head movement momentarily to positively identify an object, but **must not fixate.**

■ POC should primarily scan outside aircraft and trust PNOC to provide information (i.e., systems status, altitude, airspeed).

■ When PNOC stops scanning (e.g., to study map), he must alert POC and crewmembers. POC and other crewmembers must then enlarge their scan patterns accordingly.

■ If pilot on controls discontinues scanning outside aircraft, he should transfer controls or coordinate with other crewmembers to ensure obstacle clearance is maintained.

■ NOE mode of flight demands increased scanning outside the aircraft, especially at higher airspeeds (e.g., 40 kt), for obstacle clearance and closure rates.

■ Increased scanning outside the aircraft is even more critical in contour than NOE flight mode.

■ Crew should scan for visual cues that indicate approaching terrain transition (see Section III-D).

ADJUSTING SEAT POSITION FOR OPTIMUM FIELD OF VIEW. For those aircraft and crew positions with adjustable seats, pilots can achieve optimum viewing position by adjusting seat to "design eye point" (DEP). A field expedient procedure follows:

■ **Step 1.**

• *UH-60, UH-1, and CH-47.* Position a person directly to the front of the seat for which DEP is being determined (e.g., outside aircraft directly in front of pilot seat).

❑ UH-60 and UH-1: Position person 12 feet from nose of aircraft.

❑ CH-47: Position person 20 feet from nose of aircraft.

• *AH-1 back seat.* Position a person at 2 o'clock position, a distance of 6.5 feet from right skid toe ring.

■ **Step 2.** Have person crouch down and position fingers such that they just barely touch the ground.

■ **Step 3.** Pilot then adjusts seat until person's fingers can be seen touching the ground.

OBSTACLE DETECTION

■ Is best when moon is behind aircraft.

■ Is worst when moon is in front of aircraft.

BAND-PASS FILTER/PINK LIGHT (see Section VII-B)

■ Tends to limit pilot's scan to within area of beam spread; a corresponding reduction in airspeed should be considered.

■ When using pink light, pilot may incorrectly infer terrain transition or change in ground slope based on artificial edge produced by beam. Therefore, avoid fixation near edge of beam and continuously cross-check information on terrain conditions (e.g., slope, texture, transition, etc.) with other crewmembers.

SECTION IX

RISK MANAGEMENT

There are inherent risks associated with NVG operations that Army leaders should strive to identify and eliminate. The following risk management process is standard; however, it includes risks specific to desert terrain.

A. DEFINITION

Risk management is the process of identifying risks associated with a particular operation, weighing these risks against the overall value to be gained, and making risk acceptance decisions.

B. RISK MANAGEMENT RULES

■ 1. Accept no unnecessary risks (i.e., risk that, if eliminated, still allows mission accomplishment).

■ 2. Make decisions at proper level: Leader responsible for the mission should make risk decisions.

■ 3. Accept risks if benefits outweigh costs: Risk-taking requires a decision-making process that balances mission benefits with costs.

C. RISK MANAGEMENT PROCESS

A five-step process which includes:

- Risk identification.
- Risk assessment.
- Risk decisions and development of controls.
- Implementation of controls.
- Supervision.

A thorough SOP should be written that includes a model where values can be applied to quantify the risk for evaluation and decision making.

The following table depicts an overall comparative risk analysis of the most critical NVG mission considerations in the Southwest Asian environment.

Higher values (1–5) represent comparatively HIGHER risk.

MOON		TERRAIN TYPE		
ANGLE (Degrees)	ILLUMINATION (Percent)	DUNE	SCRUB	LAKE BED
0 - 30	0 - 35	5	4	3
31 - 60	36 - 60	4	3	2
61 - 90	61 - 80	3	2	1
61 - 90	81 - 100	4	3	2

NOTE: Contour - Add 2
NOE - Add 1
Low level - Add 0

TABLE USE:

■ When moon angle and illumination level combination is included in the same row, select the risk value for the applicable terrain and adjust for mode of flight (as indicated by the note).

■ When specific moon angle and illumination combination is not included in the same row, identify the risk values for the applicable moon angle and illumination level. Use the higher of the two risk values and adjust for mode of flight (as indicated by the note).

EXAMPLE: For a mission conducted in the dunes at NOE when moon angle is 40 degrees and illumination level is 70 percent: The risk value for 40-degree moon angle is 4, and the value for 70-percent illumination is 3. Select the higher value of 4 and adjust for NOE flight by adding 1, for a total risk value of 5.

RISK IDENTIFICATION

■ Identify risks associated with all specified and implied tasks. Consideration of basic METT-T and NVG-specific METT-T (Section IX-D) will help identify risks.

■ Thorough operations/mission analysis is required during this step to identify risk in every aspect of the operation.

RISK ASSESSMENT (EVALUATION/QUANTIFICATION)

■ Determine how great the risk is (likelihood and extent of accidental loss).

■ METT-T format provides guidelines on issues to consider (such as weather, type of terrain, and illumination levels).

■ Consider use of a risk matrix or decision guide for all or part of the operation. They can provide a quick overview of the risk situation.

RISK DECISIONS AND DEVELOPMENT OF CONTROLS

■ Determine which risks are acceptable. (The benefits of taking a risk must outweigh the possible cost of the risk.)

■ Identify actions to eliminate or reduce risk (controls). Reduction methods range from hazard awareness to development of detailed operational procedures.

■ List and prioritize alternate courses of action.

■ Ensure risk management decisions are made at the proper level. (The leader responsible for the mission should make risk decisions.)

IMPLEMENTATION OF CONTROLS

■ Knowledge of risk controls, down to the individual soldier, is essential for successful implementation and execution.

■ Integrate controls (developed in previous step) into selected courses of action to reduce risk to lowest possible levels and still accomplish the mission.

SUPERVISION

■ Enforce controls and standards.

■ Determine effectiveness of controls. Correct supervision will identify those control measures that are not effective or hinder mission objectives.

D. NVG-SPECIFIC METT-T CONSIDERATIONS

The following METT-T considerations specific to night/NVG desert operations are provided to provoke thought about issues to consider in risk management actions. They are not all inclusive.

MISSION (complexity and difficulty)

■ Raise awareness levels of leaders and aviators, to include ground elements, on NVG desert operations and associated limitations.

■ Advise OPCON, attached GS, and/or separate units of NVG-specific requirements.

■ Exchange unit NVG lessons learned and put in writing.

■ Establish a command climate that promotes safety.

■ Enforce standards—make on-the-spot corrections.

■ Deploy standardization/safety personnel with unit.

■ Establish a deployable library (training, standardization, maintenance (e.g., unit messages)).

■ Compare NVG mission risk assessment for Southwest Asia versus home station. (There are some significant differences between the flying environment in Southwest Asia and flying at the National Training Center (NTC) (e.g., lack of visual cues). Aviators must not assume that prior training at NTC is sufficient.)

■ Develop a plan for re-establishment of ground reference.

■ Establish inadvertent IMC procedure for area of operations.

■ Emphasize that brownout conditions are prevalent in bivouac sites.

■ Conduct a survey of the area of operations at once; route reconnaissance for NVG hazards becomes critical.

- Establish hazards maps and include NVG-related hazards (e.g., dunes, terrain transition areas, etc.).
- Establish restricted flight areas.
- Include hazards/obstacles in mission-crew

briefings.

■ Identify and brief in detail critical tasks for each mission.

■ Note that NVGs are helpful in AH-64s during multi-ship operations to track other aircraft and overcome IR cross-over conditions (FLIR).

■ CH-47s—

• Must use reach pendants to hook up load.

• Should sling HMMWVs side by side instead of tandem rig in order to avoid interfering with radar altimeter operation.

• Should plan to operate at altitude of 100 feet AGL or higher during all external load operations.

■ Increase emphasis on—

• Extended cross-FLOT missions.

• Resupply conducted under NVG.

• A2C2 NVG-specific issues.

• Use of AN/AVS-6 instead of AN/PVS-5.

ENEMY

■ Limited ability to detect aircraft IR lighting (band-pass filter, position lights).

■ Aviation assets not trained to fight at night.

TERRAIN (all aspects of physical environment; e.g., type terrain, weather, illumination)

■ Desert flight considerations (see Section III: NVG Terrain Flight).

■ Illumination considerations (see Section II: Illumination).

■ Visual illusions (see Section IV: Visual Illusions).

TROOPS (supervision, experience, training, equipment, etc.)

■ Increase unit emphasis on cockpit crew coordination and scanning.

■ Establish structured/planned in-country training programs:

• "Crawl-Walk-Run" training progression: Day flights—high-illumination flights—low-illumination flights.

• Establish training routes in all types of terrain.

■ The most experienced NVG pilot is at risk if not given proper in-country training.

■ Expect longer NVG missions.

■ Expect to require more NVG-qualified crews.

■ Crew endurance

• Initially, expect circadian rhythm/acclimatization to have a major impact on unit's ability to conduct NVG operations.

• Improve crew rest by providing separate accommodations for day and night crews.

• Due to high reflectance of sand, protect eyes from sunlight during the day to prevent potential adverse effects on vision.

■ Crew selection

• Battle-roster crews are a must.

• Experience is key to success—the more demanding the mission, the more experienced the crew.

• Total crew ability, not just individual crewmember proficiency, should be considered.

TIME (available for planning, preparation, and execution)

■ Allow as much time as possible for detailed mission planning.

■ Allow more time for task accomplishment (use reverse planning sequence).

SECTION X

REFERENCES

C2NVEO Pam 9102-001, Aviator's Night Vision Terrain Perception Enhancement Kit for the OH-58 and UH-60: Installation/Operation/Maintenance Guide, U.S. Army Communications and Electronics Command Center for Night Vision and Electro-Optics, Fort Belvoir, Virginia, 8 January 1991.

Desert Shield Leader's Safety Guide, First and Second Editions, U.S. Army Safety Center, Fort Rucker, Alabama, August 1990 and December 1990.

FM 1-202: Environmental Flight, 23 February 1983.

Message, USAAVNC, ATZQ-ATB-NS, 221645Z Dec 90, subject: Nonrated Crew Member Night Vision Goggle Training.

Message, USAAVNC, ATZQ-ATB-NS, 032330Z Jan 91, subject: Night Vision Goggle Scanning and Crew Coordination Errors.

TC 1-201: Tactical Flight Procedures, 20 January 1984.

TC 1-204: Night Flight Techniques and Procedures, December 1988.

U.S. Army Aviation Desert Operations Tactics, Techniques, and Procedures, Southwest Asia Focus, U.S. Army Aviation Center, Fort Rucker, Alabama, November 1990.